Climate Change Fuel Cell Program

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Abstract

Since June of 1997 a phosphoric acid fuel cell has been in place at the Double Tree Inn in Spokane, Washington. This stationary 200kW fuel cell is a phosphoric acid type fuel cell manufactured by ONSI Corporation. This fuel cell which has been in place for more than one year is designed to provide 200kW to the Double Tree Inn. The 200 kW of generation this fuel cell produces is approximately the minimum load the hotel experiences. Due to various building code requirements, the fuel cell is not considered an emergency backup power source and therefore the Double Tree Inn still has its diesel generator in place.

This fuel cell was purchased and installed as a demonstration project for the Washington Water Power Company now Avista Corporation, in order that the Avista Corporation would be able to better understand this type of technology and where it may be applicable. Avista Corporation is a hydro based utility, with the various environmental issues throughout the world and the changes occurring in the utility industry, it is important for Avista to understand new technologies that may change the how a utility operates.

This report details the installation, how it operated during the first 12 months, the interface with the Double Tree Inn and problems that occurred during that time.

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Executive Summary

Phosphoric acid fuel cell technology has been used successfully for at least the last 30 years. NASA has made good use of the phosphoric acid fuel cell in their fascinating space exploration program. As a result of the space program phosphoric acid fuel cell technology has advanced many fold from its inception.

From a utility standpoint many different types of electrical generating power plants have been experimented with and built to generate electricity over the years. The types of power plants that have been built are based on many different factors, for example numbers of customers to be served, availability of fuel, environmental conditions, where customers are located and requirements of the customers.

In regions such as the northwest where rivers are abundant and water is plentiful hydroelectric power plants are commonly used to generate electricity. In other parts of the country where fossil fuel is abundant or can be obtained coal fired power is used predominantly. Other areas of the country have limited fossil fuel sources or unacceptable river systems. These areas have turned to nuclear power as their energy source of choice. However since about 1973 no additional nuclear plants have been built in the United States and there aren't plans to build new nuclear projects at this time. There are some regions using solar, wind or geothermal power. However with the changing demographics, the emphasis on lower electric rates and the concern about the environment, the types of power plants being built are in transition.

Currently in the United States and around the world many areas are rushing to install combustion turbines that use natural gas and some plants have oil as a back up. A few years ago this was unheard of when the use of natural gas and oil to generate electricity was discouraged.

As deregulation occurs in the utility industry competition is a driving factor to decrease costs to generate electricity. The future of generating, distributing and transmitting electric energy may and will change in the next few years. We are seeing an emphasis on cost cutting and doing more with less. The competition is fueled by the trading of electricity by marketers in the utility industry. This is in part due to competition in a deregulated market. In addition environmental concerns are emphasized even more and this emphasis will not decrease.

With the added emphasis on competition, the deregulated market and with continued emphasis on environmental concerns, fuel cell technology becomes a viable alternative under specific circumstances.

There is continued discussion regarding the breaching of dams in the Pacific Northwest with the emphasis on the lower Snake River. Even though these discussions may take

years to become a reality, there is a strong possibility that some dams in the Pacific Northwest on the Snake River or other rivers may eventually be breached.
As these changes loom in the future it is prudent for any utility to understand how new electric generating technologies may be applied. It is also important for a utility that once was regionally focussed and is now becoming globally focussed, to understand how other options fit in other regions where they are not headquartered.

There is already much discussion surrounding distributed generation. This type of generation eliminates the need to build huge centralized power plants that have long transmission lines connecting them to the end user.

As a result of these potential changes in the utility industry Avista Corporation is being proactive. In order to meet the needs of the customer in the future a technology being studied is fuel cell. To understand new technology including weighing the pros and cons one must be able to observe it first hand and see it in operation.

Introduction

Avista Corporation was given the opportunity to enter into the fuel cell curriculum with the grant program provided by the federal government. Without the grant program Avista Corporation would not have been able to justify the expense of a fuel cell in the Pacific Northwest region. The fuel cell purchased was manufactured by ONSI Corporation. ONSI is a subsidiary of International Fuels Cells Corp. (IFC). The fuel cell purchased is a PC25 Model C phosphoric acid unit. This fuel cell produces a maximum continuous net electrical output of 200 kW / 235 kVA. (It is serial number S/N 9117.)

The fuel cell is located at a hotel in Spokane, WA, the Double Tree Inn, 322 N. Spokane Falls Court. The fuel cell operates on pipeline natural gas delivered at pressures between 4 and 14 inches of water column. It provides the hotel's minimum electric load of 200 kW and supplements their hot water requirements by using the waste heat from the fuel to preheat water.

This fuel cell consumes 1900 (+/- 5 %) standard cubic feet per hour of natural gas with a higher heating value of 1000 Btu per cubic foot.

The following information is included in the following report:

-MTBF (mean time between forced outage)
-cost benefit
-reliability
-thermal output

Results and Discussion

Mean Time Between Forced Outage

ONIS's PC25-C fuel cell performed well during the first year of operation and was seen as a benefit to the hotel. The physical location of the fuel cell is on the north side of the Double Tree Inn and about 200 feet from the bank of the Spokane River. The fuel cell is somewhat protected from the weather. A concrete block wall was constructed and is screening the fuel cell from weather conditions that move from west to east. The south side of the fuel cell fronts the hotel building structure, which is 3 stories tall. The north and west side of the fuel cell are not protected from the elements but are secured by a chain link fence. This open fencing allows people walking by to observe the fuel cell and cooling tower. There is a brief description of how the fuel cell functions posted on the chain link fence.

The fuel cell is remotely monitored by ONSI at their headquarters in Windsor, Connecticut. Avista also monitors the fuel cell remotely on a daily basis. A report is printed out daily showing the fuel cell's performance for the past 24 hours. By printing this information, the fuel cell is monitored by an Avista employee on a daily basis and prevents the fuel cell from being taken for granted and neglected. Since ONSI monitors the fuel they know if a problem occurs first during the night due to the difference in time zones from the east coast to west coast.

One forced outage was experienced by the fuel cell during the first year of operation and was detected by Avista immediately. It was not a fuel cell problem. It occurred when the pipeline supplying natural gas to the fuel cell was severed. Based on the type of use the fuel cell experiences this site does not have onsite storage of fuel. This deficiency of onsite fuel storage was a conscience decision made by Avista before installation. If the fuel cell had onsite fuel storage as a back up and was set to supply gas in the event that fuel ceased to flow to the site this outage would not have occurred

For purposes of this report the following information is based on a time frame from July 1, 1997 to July1, 1998. During this time the following occurred:

Total hours in a year.	8760 hours
Total load time.	8668 hours
Total hot time	8698 hours
Net Megawatt hours	1714.8 Mwh
MTBFO	8668 / 1 = 8668hours

The following are reasons the fuel cell did not have a hot time of 8760 hours.

1. It was taken off line to perform required maintenance.
2. It was taken offline to retrofit some equipment that had experienced problems or failures on other similar fuel cells.
3. It went offline for about 6 hours while the severed natural gas line was repaired. (This was the forced outage.)

Since the fuel cell operates as a supplemental electric source for the Double Tree Inn, it has the luxury of being able to be isolated from the grid without a break in electric service to the hotel. When the fuel cell is taken offline the Double Tree Inn's supplemental source to heat water is lost and water must be heated solely by the boilers in the hotel's mechanical room. (As a note when the hotel is at full occupancy the existing hotel boilers cannot supply all of the hot water that is required.) Maintenance work performed during the year was scheduled on a quarterly basis per the recommendations of the manufacture. Retrofits and upgrades were included at the quarterly maintenance periods to minimize outage time. As with any generating plant, planned outages are critical managed to minimize downtime and maximize availability.

Cost Benefit

In the Pacific Northwest electric rates are quite low compared to other parts of the United States therefore it becomes difficult to justify higher cost power plants such as fuel cells for the generation of electricity for normal use. It is however very important for a utility to maintain awareness about other types of electric generation that may be viable in the future. The fuel cell is one that may be viable in the future even though at this time its cost of generating electricity is more expensive than other sources in our region excluding the capital cost.

To site a plant like the ONSI PC 25C in an area like the Pacific Northwest takes initiative to find a partner and a willingness to place money at risk. The Double Tree Inn was the company that was willing to work with Avista as that partner and Avista was willing to risk the money. The Double Tree Inn was willing to allow the fuel cell to be located on their property, interconnect the fuel cell into their electrical system, repipe their water system in order to supplement the hotel's hot water and work closely with Avista and others to insure this project would be successful. The benefits to the hotel are:

1. Less natural gas is used to heat water for the hotel.
2. Bragging rights for being the only hotel in their chain to have a fuel cell on their property.
3. The opportunity to learn if a fuel cell would be viable at any other of their hotels.

The agreement with the Double Tree Inn was structured as follows; the total cost to provide electric service by WWP (formerly Avista) would not change. The electric service to the Double Tree would be provided per tariff Rate Schedule 21 (this rate schedule is for the state of Washington). The 200kWh of electricity produced by the fuel cell would be used to provide the Double Tree Inn's minimum load. The waste heat from the fuel cell would be used to preheat the building hot water systems supplementing the thermal load. The benefit of the thermal output from the fuel cell to the Double Tree Inn would be reimbursed through a lease agreement. The fuel cell would not be considered an emergency back-up system.

The actual cost benefit of the fuel cell is difficult to calculate because of the billing method Avista is using for this specific commercial location and situation. It is an interesting discussion point in the Avista service area when attempting to justify its installation and operation from an economic point of view.

Avista is very interested in being a good environmental steward by reducing emissions from any type of electrical generating plant and finding new generating sources that minimize emissions.

From a billing standpoint the Double Tree Inn falls under tariff Rate Schedule 21. Their bills are calculated using $.04023 per kWh. The fuel cell generates electricity at about $.08

per kWh. This $.08 is calculated using the cost of natural gas at $.30 per therm under tariff Rate Schedule 21. This does not include the thermal benefit to the Double Tree Inn or the capitol costs of the project.

Regarding the thermal benefit of the fuel cell and the manner the Double Tree Inn pays for the hot water, Avista actually calculated the amount of natural gas that was used before the fuel cell was installed to heat the Double Tree Inn's hot water. A lease cost for the use of the fuel cell was calculated that equaled the savings the Double Tree Inn would realize by using the waste heat from the fuel cell. By looking at the above costs it is clear a fuel cell may not be the first choice for generating electricity as a primary source in this region. It is important for Avista, which is the current low cost private utility provider, to send strong messages to the electric industry and its customers that other generating methods are available, viable and must be considered.

It is important for any utility to draw attention to alternate methods of generating electricity for environmental reasons and to point out the power quality benefits of fuel cell technology or any other type of new electric generating technology. In addition one must emphasize the thermal benefits a fuel cell can provide that increase its overall efficiency.

Avista installed the fuel cell in a visible area to showcase and draw attention to this type of technology. Since 1974 and before, Spokane was in the convention business market promoting this area. The Double Tree Inn is located next to Spokane's convention center. It is a central hotel for people to stay when attending conventions or other events and therefore many more opportunities to view the fuel cell by interested parties occur.

The Double Tree Inn in Spokane is also just one of the many hotels in this national chain. This chain has numerous locations around the country. The fuel cell technology is being observed and considered by many inside the Double Tree Inn organization for use at other locations. This hotel chain, even though they haven't committed at this time to install other fuel cells, are considering them as an alternative for electric generation and thermal load support at other hotels.

It is apparent many of the decisions to make this type of generation feasible are intangible. In the Avista service area the benefits are not as obvious at this time but as the utility industry changes they will be easier to identify.

Reliability

The reliability of the fuel cell has been excellent during the first year of operation. On a daily basis Avista checks remotely through a modem at their office in Spokane, WA the operation of the fuel cell from the day before. ONSI also continually monitors the operation of the fuel cell remotely through a modem from their home office in South Windsor, Connecticut. ONSI will call Avista if there seems to be something of concern that should be attended to. This is done if Avista has not already noticed the problem that has occurred. The anomalies that did occur and were observed by ONSI or Avista personnel during the year did not shut the fuel cell down. The only time the fuel cell was taken offline because of a forced outage was not due to a problem within the fuel cell system but occurred when the pipeline supplying the natural gas was severed by a contractor.

The fuel cell is unmanned at a location behind the Double Tree Inn in Spokane, WA and does not present any unusual problems. This location is fenced and has constant public visibility. With this in mind the operation has not posed a problem from a security standpoint.

Thermal Output

The thermal output of the fuel cell is at least 700,000 Btu per hour. The initial thermal design report was based on information the Double Tree Inn had a need for additional hot water. During the morning hours as the guests of the hotel began to use hot water for showers and hot water in preparation for the day, the gas fired boilers for the guest rooms were unable to supply enough hot water. Also the kitchen used more hot water than could be provided by its dedicated gas fired boiler and when the laundry facilities were running at full capacity the hot the gas fired boiler dedicated to this area could not maintain the hot water temperature required.

The preliminary thermal design report indicated that with the addition of hot water produced from the fuel cell waste heat the gas fired boilers would be able to keep up with the required load for the kitchen facilities, laundry area and guest rooms.

Once the fuel cell was installed and the waste heat was used to produce hot water there was plenty of hot water at the Double Tree Inn under all conditions in the kitchen facilities, laundry area and guest rooms.

It was also discovered the information, that was given to the consultant designing the thermal system, was not totally accurate. The thermal peaks that occurred were larger than had been realized and the usage in the afternoon was less than expected. As the day would progress the thermal load would subside and the waste heat from the fuel cell used to heat the water would pass back to the fuel cell and be dissipated in the cooling water module. As a result the cooling tower operates more frequently than originally expected

Since the fuel cell has been in service the Double Tree Inn has not complained of a lack of hot water as long as the thermal loop is in service. There were, however problems with the thermal loop and the interconnections to the Double Tree Inn's hot water system unrelated to the operation of the fuel cell.

The Double Tree Inn had been built in 1974 and interconnecting the new thermal loop to supply additional hot water to the Double Tree Inn emphasized the weakness' of the old system. These preexisting problems caused the thermal loop to be shutdown for periods of time while they were repaired or examined to determine the problem. As the first year of operation continued the problems were investigated, repaired and at this time the thermal loop is working fine and to the satisfaction of the Double Tree Inn. Additional uses for the waste heat are being investigated in order to make this installation more efficient.

Conclusion

The opportunity to have a fuel cell in an area close to Avista's main office and service center has been and is an excellent opportunity to learn about phosphoric acid fuel cell technology. It also affords Avista a chance to understand the problems associated with the installation of a fuel cell and design modifications that must be made to avoid problems in the future.

With the interface of the thermal loop into an existing commercial building the sensitivity and balance of an existing system becomes quite apparent. Even with good forethought and detailed interface design problems may occur that were not apparent.

The opportunity for commercial and residential customers to actually see what a fuel cell looks, sounds and smells like and having them being able to talk to someone about its performance is a tremendous benefit. This is especially true when a technology that people have heard or read about, but only in magazines or on the news, are able so see that it is not a myth or a science project and it actually works.

Fuel cells are a part of the future for the generation of electricity. The technology is exciting. They will be part of the future and this fuel cell site is an example of what to expect. With ongoing research and improved manufacturing techniques fuel cells will become more prevalent in our society.